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A SURVEY OF THE

Pulpwood Resource

IN THE NORTHERN BLACK HILLS

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By

Gilbert H. Fechner

ROCKY MOUNTAIN FOREST AND RANGE EXPERIMENT STATION
Raymond Price, Director
Fort Collins, Colorado

FOREST SERVICE, U. S. DEPARTMENT OF AGRICULTURE

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Technologist (Forest Products)

INTRODUCTION

During recent years the production of wood-pulp and paper products has increased sharply. Wood-pulp production in the United States jumped from 4,630,308 short tons in 1930 to 17,524,929 short tons in 1953 (8).[2/] This increase in wood-pulp production is reflected by a corresponding increase in drain on our national timber

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1/ Mr. Fechner is Assistant Professor of Forest Management, School of Forestry and Range Management, Colorado A & M College, Fort Collins, Colorado. He was employed by the Rocky Mountain Forest and Range Experiment Station during the summer season of 1955 to conduct the survey and complete the report.

Acknowledgement is made to L. A. Mueller, Chief, Division of Forest Utilization Research, who planned the survey, gave direction to the work and preparation of the report. The personnel of the Black Hills National Forest were especially helpful in all phases of the study. Acknowledgement is also made to the following individuals who reviewed the report: Harry R. Woodward, State Forester, South Dakota; Hugo A. Carlson, Executive Secretary, South Dakota Natural Resource Commission; C. A. Polley, Manager, Lumber Department, Homestake Mining Company; and Arthur A. Thornton, General Sales Manager, Northwest Wood Preserving Company.

2/ Underlined numbers in parentheses refer to literature cited.

rescurce. In 1929 the volume of wood used for pulpwood constituted 4 percent of the total used. By 1952 it had increased to 16 percent (9). Today the pulp and paper industry ranks among the first 10 industries in the United States and is second only to the lumber industry in consumption of the timber resource (6).

This increase in wood-pulp production and consequent increase in overall wood requirements has reduced the raw material supply in some areas. It has caused the pulp and paper industry to seek new sources of wood. Some pulpwood operators, for example, are now going into areas that were formerly considered inoperable; into areas that yield as little as 3 cords of raw material per acre (9). In the Lake States, this problem is also reflected by the increased use of such species as jack pine (Pinus banksiana Lamb.) and quaking aspen (Populus tremuloides Michx.). The utilization of new species for wood-pulp not only indicates a reduction in the raw material supply; it is also an expression of technological advancement.

One western species that has recently come into acceptance as a source of pulpwood is ponderosa pine (Pinus ponderosa Laws.). Interest in this species has been stimulated by the results of recent experiments conducted by the pulp and paper industry and the U. S. Forest Products Laboratory. Pulps of good quality and high yield can be manufactured from ponderosa pine by all of the standard pulping processes (7, 11). The suitability of ponderosa pine as a source of groundwood pulp has been of particular interest in the semi-arid West because of the relatively low water requirements of the groundwood process.3/

In view of the trend toward utilization of new species, the ponderosa pine stands in the Black Hills of South Dakota and Wyoming have been receiving increased attention as a pulpwood supply source. Properly developed, these relatively large stands could provide greater benefits. Their development could add to the pulpwood supply. The ponderosa pine stands in many of the areas in the Black Hills are overstocked and should be thinned to place the forest in a good growing condition. An adequate local pulpwood market would provide an outlet for this material. Without such a market removal would not be economically feasible on an extensive scale. The existing post and pole market in the area, while a very desirable outlet and one to be encouraged, does not absorb the volume of material that should be removed for best management.

3/ Groundwood pulp requires a minimum of 4,000 gallons of water per metric ton avoirdupois (2204.6 lbs.) of pulp at 10 percent moisture content. The average requirement is 10,000 gallons. The cold caustic soda and neutral sulfite processes require 15,000 to 30,000 gallons per metric ton. Sulfate and sulfite pulps require 20,000 to 35,000 and 40,000 to 60,000 gallons of water respectively (2).

This survey was conducted to obtain basic information on the pulpwood resource. It was designed to determine whether a pulpwood market could be encouraged and to provide a foundation for industrial planning in the Black Hills region.

The specific objective of this study was to obtain an inventory of the pulpwood material on an area tributary to Deadwood, South Dakota, in view of the current interest in construction of a wood-pulp mill there. An area tributary to Deadwood could also supply raw material to adjacent population centers.

THE STUDY AREA

The study area consists of approximately 800,000 acres of public and private lands in the northern Black Hills. It includes the Limestone, Spearfish, Nemo, Rochford, and Pactola blocks of the Black Hills National Forest[4/] and private lands within and bordering the national forest. The area is bounded on the south by the Black Hills Base Line. It is generally delineated on the west, north, and east by the lower extent of the timber type, which is approximated by the forest boundary. The attached map (fig. 1) indicates the extent of the area surveyed.

The topography of the northern Black Hills is generally rolling to rough. However, an excellent network of roads provides ready access to practically all sections. The climate is conducive to year-round logging.

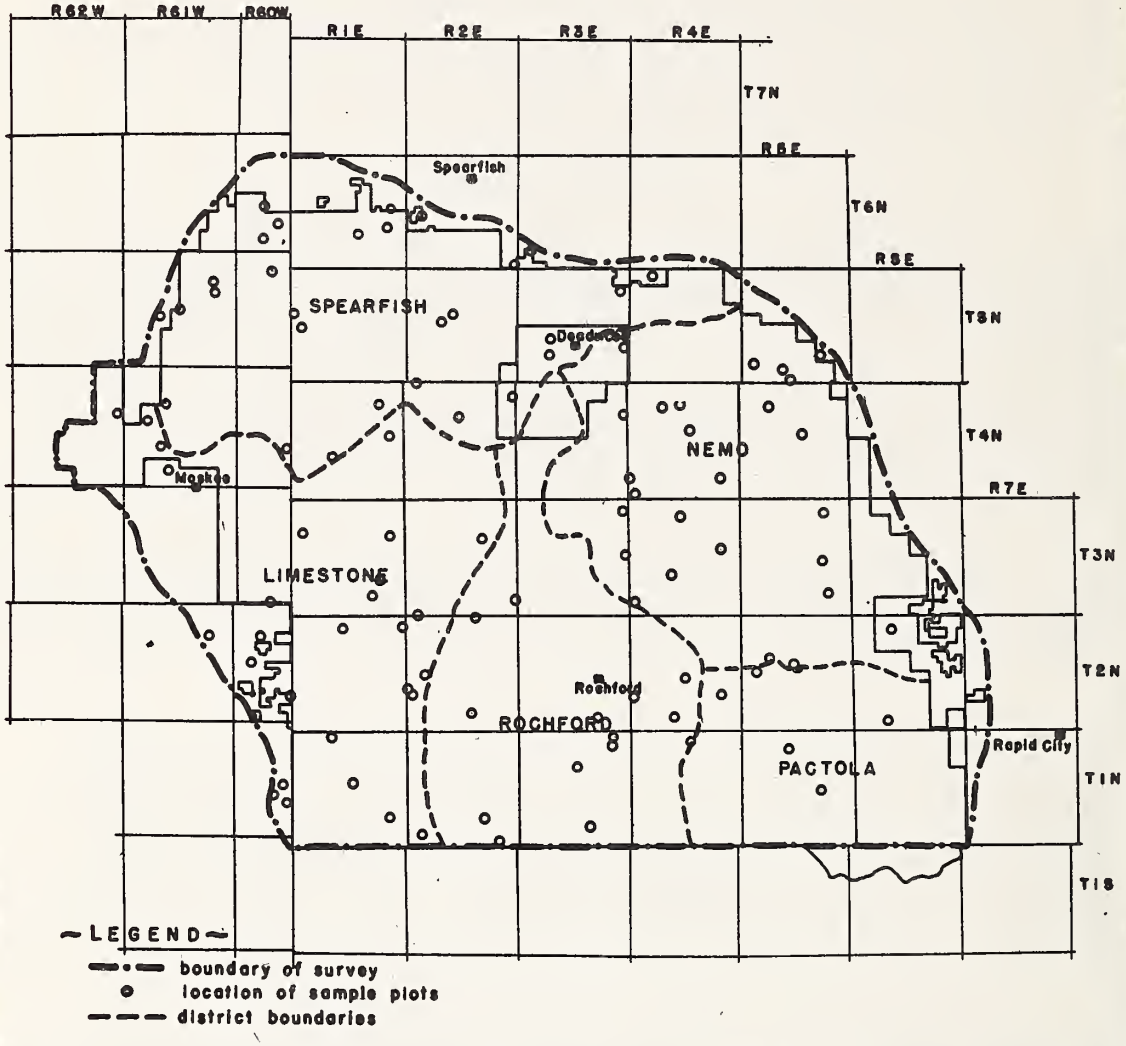
Ninety-two percent of the northern Black Hills is forested. The principal commercial timber type is ponderosa pine. A small portion of the forested land (1 percent), especially along stream bottoms, is occupied by white spruce (Picea glauca (Moench) Voss). Lesser amounts of quaking aspen, paper birch (Betula papyrifera Marsh.), and burr oak (Quercus macrocarpa Michx.) are present, but they seldom reach merchantability in size or volume and may be of greater value for wildlife habitat, and watershed protection.

For purposes of timber management, four timber age classes are recognized on the Black Hills National Forest. They are 0 to 50 years, 51 to 100 years, 101 to 160 years, and 161+ years. Areas completely logged during the past 50 years (age class 0 to 50 years) are generally well-stocked with reproduction. Most of the timber in this age class has not yet reached merchantable size for pulpwood. Many such areas need thinning to increase annual growth.

4/ The Limestone and Spearfish blocks are part of the Spearfish Working Circle. Nemo, Rochford, and Pactola blocks comprise the Rapid Creek Working Circle (10).

FIGURE

PULPWOOD SURVEY AREA IN THE BLACK HILLS



Timber in the age class 51 to 100 years is largely pulpwood size and represents the major supply source at the present time. Many stands in this age class also need thinning. Some are being thinned through post and pole sales; many are not. In the Rapid Creek Working Circle, only about half of the annual growth in small material is being removed (10). An active pulpwood market would help solve the management problems in this age class, in view of the thinning it would provide.

It is not anticipated that the demands for pulpwood will become sufficiently strong to conflict seriously with the existing post and pole industry. Should it become necessary provision will be made in the forest management policy to assure the pole and post industry the required supply of raw material.

Certain unthinned stands in the 101- to 160-year age class also contain merchantable pulpwood material. On these areas, the pulpwood generally occurs in mixture with sawtimber-size trees. Since some of the sawtimber trees are ready for harvest, it would be advantageous if both products were removed simultaneously.

Lesser areas of age class 161+ years contain suppressed trees of pulpwood size or advanced reproduction which is approaching merchantability for cordwood. Here again, overall logging costs could be reduced by removing the pulpwood when the sawtimber is cut. The estimated acreages in the study area by forest type and age class are given in table 1.

PROCEDURE

The current study was limited to the sampling of two age classes of the ponderosa pine type: 51 to 100 years and 101+ years. Hence, the two oldest age classes (101 to 160 years and 161+ years) were combined. The youngest age class (0 to 50 years) was not sampled. The survey was designed to determine the volume of pulpwood available within an accuracy of $\pm$ 15 percent in each of the two age classes sampled.

To obtain the desired accuracy, it was necessary to measure 103 sample plots. These were randomly located over the study area (see map, fig. 1). Forty plots fell in the 51- to 100-year age class; 63 in the 101+-year age class. Timber type maps in use on the Black Hills National Forest were used for plot location control.

The three major forest sites, established in Black Hills ponderosa pine management, were recognized. Generally, the three sites refer to stream bottom, sidehill, and ridge top, with minor adjustments as affected by soil depth and aspect (4).

Table 1.--Estimated Area by Forest Type, Age Class, and Land Ownership--Black Hills Pulpwood Survey Area[1/]

Land Ownership	Reproduction 0 to 50 yrs.		Poles 51 to 100 yrs.		Thrifty Merch. 101 to 160 yrs.		Mature Merch. 160+ yrs.		Inaccessible	Non-Timbered	Total
	Pine	Spruce	Pine	Spruce	Pine	Spruce	Pine	Spruce			
National Forest	131,639	621	118,245	609	213,505	---	49,968	3,534	4,350	48,054	570,525
State & Other Federal	223	---	277	1	528	---	141	3	2	74	1,249
Interior Private	30,063	135	23,393	102	43,266	---	10,544	629	1,067	8,488	117,687
Adjoining Private	21,388	44	19,540	26	37,284	---	10,579	243	512	5,984	95,600
Deadwood Exemption	---	---	21,646	---	---	---	---	---	---	1,234	22,880
Total	183,313	800	183,101[2/]	738	294,583[3/]	---	71,232[3/]	4,409	5,931	63,834	807,941

1/ Black Hills National Forest and adjoining and interior public and private lands. The acreages shown by National Forest, State and other federal lands were taken from the forest management plans prepared for the Black Hills National Forest. The acreages shown for private lands were estimated on the basis of the percentage of the area of the various types found on the National forest, State and other federal lands. The areas include the Limestone, Spearfish, Nemo, Rochford, and Pactola blocks. The Inyon Kara compartment was not included since it is separated from the main area and is not a logical part of the pulpwood unit.

2/ Plot counts indicate that 67.5% (123,593 acres) of the area is operable.

3/ Plot counts indicate that 22.2% (81,211 acres) of the area in age class 101+ is operable.

Operability standards were arbitrarily set at 6 cords per acre. In other words, those stands that could now sustain a cut of 6 cords per acre were classed as operable. Those from which less than 6 cords could be cut at the present time were classed as nonoperable. With the development of an active pulpwood market, it is conceivable that operability standards might be lowered somewhat.

Pulpwood trees (6.0 to 9.9 inches d.b.h.) were tallied on 1/25-acre sample plots by 1-inch diameter classes, merchantable height to a 4-inch inside bark diameter, on cut or leave basis. A standard cubic foot volume table was constructed to convert tree measurements to volumes.

The cut or leave tally was based on the marking guide currently in use on the Black Hills National Forest. The marking guide, in turn, is based on the condition of the timber and on the site (4). This marking guide presupposes that the principal objective of ponderosa pine management in the Black Hills is the production of sawtimber. Hence, any volume removed for pulpwood, posts, or small poles, would come from intermediate cuttings, which would improve the residual stand for sawtimber.

THE PULPWOOD RESOURCE

The survey showed that the present operable supply of ponderosa pine pulpwood in the northern Black Hills is 1,243,000 rough cords (table 5).5/ This is sufficient to sustain a 50-ton capacity ground-wood pulp mill for 68 years,6/ 7/ without considering the added volume that will result from growth which in all probability would more than sustain the operation permanently.

The volume estimate is based on the volume of wood in trees 6.0 to 9.9 inches d.b.h., which should be removed to improve growing conditions under the present method of timber management in the area. After removal of the 1,243,000 cords, there would still be a reserve stand of 2,197,000 cords. This reserve includes 212,000 cords that

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5/ The accuracy of estimate at 1 standard error was found to be ± 12.1 percent for the 51- to 100-year age class; ± 15.7 percent for the 101+-year age class.

6/ Based on an assumed requirement of 55 cords of rough wood per day and a working year of 330 days.

7/ Should it be desirable to harvest trees 10 inches in d.b.h. for pulpwood an additional 144,000 cords of pulpwood would become available. Of this amount 123,000 would come from trees 10 inches in d.b.h. and 21,000 cords from trees 6 to 9 inches in d.b.h., which are located in areas that are considered inoperable unless the 10 inch d.b.h. trees are included. This would permit an increase of about 8 years of operation for a 50-ton mill.

should be cut, but this volume is on areas now classed as nonoperable. Detailed information of the pulpwood resource is presented in tabular form on pages 10 to 18 and is broken down under the following categories:

Cubic Foot Volume by Age Class and Land Ownership
Cord Volumes by Age Class and Land Ownership
Cubic Foot Volume by Age Class and Operability
Cord Volume of Pulpwood by Age Class and Operability
Cubic Volume of Pulpwood by Age Class and Site
Cord Volume of Pulpwood by Age Class and Site
Number of Pulpwood-size Trees by Age Class and Tree Diameter
Cubic Foot Volume of Pulpwood by Age Class and Diameter
Cord Volume of Pulpwood by Age Class and Diameter

It should be reemphasized that the present objective of timber management on the Black Hills National Forest is the production of sawtimber. The removal of pulpwood is primarily a cultural operation; an intermediate cutting. Hence, it seems reasonable that two-thirds of the available wood would come from stands in the 51- to 100-year age class, which are in need of thinning. One-third of the volume would come from the older age class and should be concurrent with the removal of some sawtimber from the same areas.

Two-thirds of the total stand of 3,440,000 cords of pulpwood-size ponderosa pine is on National Forest land, which also occupies about two-thirds of the land area in the age classes studied. Approximately 40 percent of the pulpwood-size ponderosa pine in public ownership on the area surveyed should be cut now; the corresponding cut for private ownership would be about 46 percent.

Sixty-seven percent of the pine pulpwood volume was found on site two; 22 percent was on site one; 11 percent on the poorest sites. Sites correspond with those recognized on Black Hills National Forest as described by Harmon (4).

No data were collected during the survey on timber growth. However, as is shown in table 1 there is approximately the same acreage in the 0- to 50-year age class (presently below pulpwood size) as there is in the 51- to 100-year age class, which is now ready for cutting. As this young age class moves up, it is reasonable to assume that similar volumes will become available as are now available from the 51- to 100-year age class. A second cut can also be anticipated in the 51- to 100-year age class. Thus any reasonable allowance for growth would assure a sustained pulpwood supply for a 50-ton groundwood pulpmill.

Another source of pulp material is unused sawmill waste. Kotok and Myers (5) have estimated that approximately 1.9 million cubic feet of solid, chippable material is made available annually by

sawmills in the area. In some places, where the pulp and paper industry has become established, such a source of raw material has become popular. For example, in 1952, 30 percent of the pulpwood output in the Pacific Northwest came from plant residues (1).

In planning for the establishment of a pulpmill, other factors such as cost of raw material, adequate water supply, suitable markets, and other economic aspects should also be considered.

SUMMARY

Recent increases in wood-pulp and paper production have raised consumption of the nation's timber resource. This has stimulated a search for new areas and new species to supply raw material.

Interest is currently focused on the ponderosa pine stands throughout much of its range because they constitute a large untapped source of raw material for the expanding pulp and paper industry.

Properly developed, these stands can bring increased benefits. The current survey shows that stands in the northern Black Hills can now supply enough raw material to sustain a prospective 50-ton groundwood pulp mill for about 68 years without taking credit for growth which would more than likely sustain the supply permanently. This raw material would come from intermediate cuttings; from trees 6.0 to 9.9 inches d.b.h. Removal of these trees would improve the stand and increase annual growth on remaining trees left for future sawtimber.

Table 2.--Cubic Foot Volume of Pulpwood by Age Class and Land Ownership--Black Hills Pulpwood Survey Area

Age class (years) / Species	Public			Private			Total		
	Cut	Leave	Total	Cut	Leave	Total	Cut	Leave	Total
	Thousand Cubic Feet								
51-100 years									
P. Pine	40,045	56,448	96,493	20,241	36,825	57,066	60,286	93,273	153,559
Spruce	893	---	893	---	---	---	893	---	893
Bir. & Asp.	2,975	---	2,975	1,557	---	1,557	4,532	---	4,532
Total	43,913	56,448	100,361	21,798	36,825	58,623	65,711	93,273	158,984
101+ years									
P. Pine	24,005	37,038	61,043	15,647	6,039	21,686	39,652	43,077	82,729
Spruce	7,578	---	7,578	---	---	---	7,578	---	7,578
Bir. & Asp.	1,408	---	1,408	---	---	---	1,408	---	1,408
Total	32,991	37,038	70,029	15,647	6,039	21,686	48,638	43,077	91,715
Total									
P. Pine	64,050	93,486	157,536	35,888	42,864	78,752	99,938	136,350	236,288
Spruce	8,471	---	8,471	---	---	---	8,471	---	8,471
Bir. & Asp.	4,383	---	4,383	1,557	---	1,557	5,940	---	5,940
Total	76,904	93,486	170,390	37,445	42,864	80,309	114,349	136,350	250,699

Table 3.--Cord Volume of Pulpwood by Age Class and Land Ownership--Black Hills Pulpwood Survey Area

Age class (years) / Species	Public			Private			Total		
	Cut	Leave	Total	Cut	Leave	Total	Cut	Leave	Total
	Thousand Cords								
51-100 years									
P. Pine	583	822	1,405	295	536	831	878	1,358	2,236
Spruce	13	---	13	---	---	---	13	---	13
Bir. & Asp.	43	---	43	22	---	22	65	---	65
Total	639	822	1,461	317	536	853	956	1,358	2,314
101+ years									
P. Pine	349	539	888	228	88	316	577	627	1,204
Spruce	110	---	110	---	---	---	110	---	110
Bir. & Asp.	21	---	21	---	---	---	21	---	21
Total	480	539	1,019	228	88	316	708	627	1,335
Total									
P. Pine	932	1,361	2,293	523	624	1,147	1,455	1,985	3,440
Spruce	123	---	123	---	---	---	123	---	123
Bir. & Asp.	64	---	64	22	---	22	86	---	86
Total	1,119	1,361	2,480	545	624	1,169	1,664	1,985	3,649

Table 4.--Cubic Foot Volume of Pulpwood by Age Class and Operability--Black Hills Pulpwood Survey Area

Age Class (Years) / Species	Operable			Nonoperable			Total		
	Cut	Leave	Total	Cut	Leave	Total	Cut	Leave	Total
	Thousand Cubic Feet								
51-100 years									
P. Pine	57,977	77,554	135,531	2,309	15,719	18,028	60,286	93,273	153,559
Spruce	893	---	893	---	---	---	893	---	893
Bir. & Asp.	2,054	---	2,054	2,478	---	2,478	4,532	---	4,532
Total	60,924	77,554	138,478	4,787	15,719	20,506	65,711	93,273	158,984
101+ years									
P. Pine	27,450	16,973	44,423	12,202	26,104	38,306	39,652	43,077	82,729
Spruce	---	---	---	7,578	---	7,578	7,578	---	7,578
Bir. & Asp.	---	---	---	1,408	---	1,408	1,408	---	1,408
Total	27,450	16,973	44,423	21,188	26,104	47,292	48,638	43,077	91,715
Total									
P. Pine	85,427	94,527	179,954	14,511	41,823	56,334	99,938	136,350	236,288
Spruce	893	---	893	7,578	---	7,578	8,471	---	8,471
Bir. & Asp.	2,054	---	2,054	3,886	---	3,886	5,940	---	5,940
Total	88,374	94,527	182,901	25,975	41,823	67,798	114,349	136,350	250,699

Table 5.--Cord Volume of Pulpwood by Age Class and Operability--Black Hills Pulpwood Survey Area

Age class (years) / Species	Operable			Nonoperable			Total		
	Cut	Leave	Total	Cut	Leave	Total	Cut	Leave	Total
	Thousand Cords								
51-100 years									
P. Pine	844	1,129	1,973	34	229	263	878	1,358	2,236
Spruce	13	---	13	---	---	---	13	---	13
Bir. & Asp.	29	---	29	36	---	36	65	---	65
Total	886	1,129	2,015	70	229	299	956	1,358	2,314
101+ years									
P. Pine	399	247	646	178	380	558	577	627	1,204
Spruce	---	---	---	110	---	110	110	---	110
Bir. & Asp.	---	---	---	21	---	21	21	---	21
Total	399	247	646	309	380	689	708	627	1,335
Total									
P. Pine	1,243	1,376	2,619	212	609	821	1,455	1,985	3,440
Spruce	13	---	13	110	---	110	123	---	123
Bir. & Asp.	29	---	29	57	---	57	86	---	86
Total	1,285	1,376	2,661	379	609	988	1,664	1,985	3,649

Table 6.--Cubic Foot Volume of Pulpwood by Age Class and Site--Black Hills Pulpwood Survey Area

Age Class (Years) / Species	Site 1 Cut	Site 1 Leave	Site 1 Total	Site 2 Cut	Site 2 Leave	Site 2 Total	Site 3 Cut	Site 3 Leave	Site 3 Total	Total Cut	Total Leave	Total Total
	Thousand Cubic Feet											
51-100 years												
P. Pine	17,759	26,758	44,517	37,742	53,506	91,248	4,785	13,009	17,794	60,286	93,273	153,559
Spruce	---	---	---	893	---	893	---	---	---	893	---	893
Bir. & Asp.	2,793	---	2,793	1,739	---	1,739	---	---	---	4,532	---	4,532
Total	20,552	26,758	47,310	40,374	53,506	93,880	4,785	13,009	17,794	65,711	93,273	158,984
101+ years												
P. Pine	3,695	5,118	8,813	34,381	31,861	66,242	1,576	6,098	7,674	39,652	43,077	82,729
Spruce	3,118	---	3,118	4,460	---	4,460	---	---	---	7,578	---	7,578
Bir. & Asp.	1,013	---	1,013	395	---	395	---	---	---	1,408	---	1,408
Total	7,826	5,118	12,944	39,236	31,861	71,097	1,576	6,098	7,674	48,638	43,077	91,715
Total												
P. Pine	21,454	31,876	53,330	72,123	85,367	157,490	6,361	19,107	25,468	99,938	136,350	236,288
Spruce	3,118	---	3,118	5,353	---	5,353	---	---	---	8,471	---	8,471
Bir. & Asp.	3,806	---	3,806	2,134	---	2,134	---	---	---	5,940	---	5,940
Total	28,378	31,876	60,254	79,610	85,367	164,977	6,361	19,107	25,468	114,349	136,350	250,699

Table 7.--Cord Volume of Pulpwood by Age Class and Site--Black Hills Pulpwood Survey Area

Age Class (Years) / Species	Site 1			Site 2			Site 3			Total		
	Cut	Leave	Total	Cut	Leave	Total	Cut	Leave	Total	Cut	Leave	Total
	Thousand Cords											
51-100 years												
P. Pine	259	390	649	549	779	1,328	70	189	259	878	1,358	2,236
Spruce	---	---	---	13	---	13	---	---	---	13	---	13
Bir. & Asp.	40	---	40	25	---	25	---	---	---	65	---	65
Total	299	390	689	587	779	1,366	70	189	259	956	1,358	2,314
101+ years												
P. Pine	54	74	128	500	464	964	23	89	112	577	627	1,204
Spruce	45	---	45	65	---	65	---	---	---	110	---	110
Bir. & Asp.	15	---	15	6	---	6	---	---	---	21	---	21
Total	114	74	188	571	464	1,035	23	89	112	708	627	1,335
Total												
P. Pine	313	464	777	1,049	1,243	2,292	93	278	371	1,455	1,985	3,440
Spruce	45	---	45	78	---	78	---	---	---	123	---	123
Bir. & Asp.	55	---	55	31	---	31	---	---	---	86	---	86
Total	413	464	877	1,158	1,243	2,401	93	278	371	1,664	1,985	3,649

Table 8.--Number of Pulpwood-Size Trees by Age Class and Tree Diameter--Black Hills Pulpwood Survey Area

Species	d.b.h.	51 to 100 years			101+ years			Total		
		Cut	Leave	Total	Cut	Leave	Total	Cut	Leave	Total
	Inches	Thousand Trees								
P. Pine	6	5,379	4,577	9,956	3,339	2,323	5,662	8,718	6,900	15,618
	7	4,577	4,577	9,154	3,048	2,323	5,371	7,625	6,900	14,525
	8	2,632	4,349	6,981	1,887	2,468	4,355	4,519	6,817	11,336
	9	1,488	4,349	5,837	1,307	2,177	3,484	2,795	6,526	9,321
	Total	14,076	17,852	31,928	9,581	9,291	18,872	23,657	27,143	50,800
Spruce	6	114	---	114	290	---	290	404	---	404
	7	229	---	229	436	---	436	665	---	665
	8	---	---	---	290	---	290	290	---	290
	9	---	---	---	436	---	436	436	---	436
	Total	343	---	343	1,452	---	1,452	1,795	---	1,795
Bir. & Asp.	6	114	---	114	436	---	436	550	---	550
	7	229	---	229	---	---	---	229	---	229
	8	114	---	114	---	---	---	114	---	114
	9	229	---	229	---	---	---	229	---	229
	Total	686	---	686	436	---	436	1,122	---	1,122
Total	6	5,607	4,577	10,184	4,065	2,323	6,388	9,672	6,900	16,572
	7	5,035	4,577	9,612	3,484	2,323	5,807	8,519	6,900	15,419
	8	2,746	4,349	7,095	2,177	2,468	4,645	4,923	6,817	11,740
	9	1,717	4,349	6,066	1,743	2,177	3,920	3,460	6,526	9,986
	Total	15,105	17,852	32,957	11,469	9,291	20,760	26,574	27,143	53,717

Table 9.--Cubic Foot Volume of Pulpwood by Age Class and Diameter--Black Hills Pulpwood Survey Area

Species	d.b.h.	51 to 100 years			101+ years			Total		
		Cut	Leave	Total	Cut	Leave	Total	Cut	Leave	Total
	Inches	Thousand Cubic Feet								
P. Pine	6	14,705	12,440	27,145	9,029	5,102	14,131	23,734	17,542	41,276
	7	18,768	20,788	39,556	12,332	8,870	21,202	31,100	29,658	60,758
	8	15,289	25,382	40,671	9,915	12,658	22,573	25,204	38,040	63,244
	9	11,524	34,663	46,187	8,376	16,447	24,823	19,900	51,110	71,010
	Total	60,286	93,273	153,559	39,652	43,077	82,729	99,938	136,350	236,288
Spruce	6	160	---	160	508	---	508	668	---	668
	7	733	---	733	1,394	---	1,394	2,127	---	2,127
	8	---	---	---	1,466	---	1,466	1,466	---	1,466
	9	---	---	---	4,210	---	4,210	4,210	---	4,210
	Total	893	---	893	7,578	---	7,578	8,471	---	8,471
Bir. & Asp.	6	309	---	309	1,408	---	1,408	1,717	---	1,717
	7	1,122	---	1,122	---	---	---	1,122	---	1,122
	8	881	---	881	---	---	---	881	---	881
	9	2,220	---	2,220	---	---	---	2,220	---	2,220
	Total	4,532	---	4,532	1,408	---	1,408	5,940	---	5,940
Total	6	15,174	12,440	27,614	10,945	5,102	16,047	26,119	17,542	43,661
	7	20,623	20,788	41,411	13,726	8,870	22,596	34,349	29,658	64,007
	8	16,170	25,382	41,552	11,381	12,658	24,039	27,551	38,040	65,591
	9	13,744	34,663	48,407	12,586	16,447	29,033	26,330	51,110	77,440
	Total	65,711	93,273	158,984	48,638	43,077	91,715	114,349	136,350	250,699

Table 10.--Cord Volume of Pulpwood by Age Class and Diameter--Black Hills Pulpwood Survey Area

Species	d.b.h.	51 to 100 years			101+ years			Total		
		Cut	Leave	Total	Cut	Leave	Total	Cut	Leave	Total
	Inches	Thousand Cords								
P. Pine	6	214	181	395	131	74	205	345	255	600
	7	273	303	576	180	129	309	453	432	885
	8	223	369	592	144	184	328	367	553	920
	9	168	505	673	122	240	362	290	745	1,035
	Total	878	1,358	2,236	577	627	1,204	1,455	1,985	3,440
Spruce	6	2	---	2	7	---	7	9	---	9
	7	11	---	11	20	---	20	31	---	31
	8	---	---	---	22	---	22	22	---	22
	9	---	---	---	61	---	61	61	---	61
	Total	13	---	13	110	---	110	123	---	123
Bir. & Asp.	6	4	---	4	21	---	21	25	---	25
	7	16	---	16	---	---	---	16	---	16
	8	13	---	13	---	---	---	13	---	13
	9	32	---	32	---	---	---	32	---	32
	Total	65	---	65	21	---	21	86	---	86
Total	6	220	181	401	159	74	233	379	255	634
	7	300	303	603	200	129	329	500	432	932
	8	236	369	605	166	184	350	402	553	955
	9	200	505	705	183	240	423	383	745	1,128
	Total	956	1,358	2,314	708	627	1,335	1,664	1,985	3,649

Cubic Foot to Cord Conversion

It is most convenient to compute and express tree volumes in cubic feet. For area estimation, however, the standard cord is perhaps more commonly used.

In an effort to provide some basis for conversion of cubic foot measure to cord measure, the individual 8-foot sticks of four piles of stacked wood were measured inside and outside bark at each end. The summaries of the data thus collected are shown in table 11.

Several factors influence the solid wood content of stacked wood. Some of these factors are diameter, taper, straightness, and length of the individual sticks in the stack. Time did not permit a thorough investigation of the effects of these factors on the solid wood content of stacked Black Hills ponderosa pine. Such an investigation is strongly recommended, however. It is felt, though, that the piled wood represented average conditions and that the sizes of the individual sticks were woods-run, much as would be expected on an actual timber sale.

On the basis of the data in table 11, cubic foot volume inside bark was converted to rough cords by dividing 68.7 for the 51- to 100-year age class; by 75.7 for the 101+-year age class.

The minor amounts of white spruce, paper birch, and quaking aspen were converted to rough cords by dividing the cubic foot volume by 75.

Table 11.--Cordwood Measurements of Ponderosa Pine--Black Hills National Forest[1/]

Location	Age Class	Site	Pile Volume		Total Wood Volume		Volume per Rough Cord		Bark Content
					Rough	Peeled	Rough	Peeled	
	Years		Cu.Ft.	Cords	Cubic Feet				Percent
Nemo District	51-100	2	65.772	0.5138	43.8270	35.6958	85.30	69.47	18.56
Nemo District	51-100	2	155.232	1.2127	102.6018	82.8425	84.61	68.31	19.26
Average of both piles			221.004	1.7265	146.4288	118.5383	84.81	68.66	19.04
Hill City Dist.	101+	2	420.000	3.2813	310.4682	256.3344	94.62	78.12	17.44
Hill City Dist.	101+	2	356.328	2.7838	241.8042	202.5240	86.86	72.75	16.24
Average of both piles			776.328	6.0651	552.2724	458.8584	91.06	75.66	16.91

1/ Measurements made inside and outside bark on both ends of individual sticks in pile. Volumes computed by Smalian's formula.

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